Chapter 5
Vegetated Buffers

5.1 General Criteria

5.1.1 General Description

Buffer strips are natural, undisturbed strips of natural vegetation or planted strips of close-growing vegetation adjacent to and downslope of developed areas.

As stormwater runoff travels over the buffer area, vegetation slows the runoff and traps particulate pollutants. They are also effective for phosphorus removal when designed in accordance with this manual. The effectiveness of buffers for pollutant removal depends on the flow path length and slope of the buffer berm length, the soil permeability, the size of drainage area, and the type and density of vegetation. Also

IMPORTANT

There are four types of BMP buffers approved by DEP:

- Buffer adjacent to residential, largely pervious or small impervious areas: This buffer is for smaller areas where the flow enters the buffer as sheet flow.
- Buffer with stone bermed level lip spreaders: This buffer is used for larger, developed areas and uses a level spreader to create sheet flow onto the buffer.
- Buffer adjacent to the down hill side of a road: This buffer is used for flow from a roadway when it directly enters the buffer as sheet flow.
- Ditch turn-out buffer: This buffer is used to divert roadway runoff collected in a ditch into a buffer as sheet flow.

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critical to the performance of buffer strips is the distribution of water flowing over it. If water is allowed to concentrate because of poor grading or uneven runoff distribution, the buffer will be short-circuited and have only minimal benefit. The irregular microtopography of undisturbed buffers provides small areas within which runoff can pool, encouraging infiltration and reducing the amount of runoff.

Buffers are used to treat runoff from relatively small amounts of impervious area, as typically found in residential developments and small commercial and industrial sites. This type of BMP requires minimal maintenance and provides an aesthetically pleasing area.

This manual describes four different BMP buffers, each of which is appropriate for specific situations. This chapter is set up to present general design, construction and maintenance criteria applicable to all buffers up front, followed by specific design criteria for each buffer type.

5.1.2 General Size Suitability Criteria

IMPORTANT
Design Tips - All Buffers

- Buffers shall be directly adjacent to areas being treated.
- Buffer slope must be less than 15%.
- Runoff must enter the buffer as sheet flow.
- Manipulate sites to maximize buffer flow path length.
- Only continuous flow path length may be counted for treatment.
- Flow paths of runoff through a buffer must be parallel or diverging; they must not converge.

1. **Drainage Area:** The required size and type of buffer used is dependent on the size and land use characteristics of the area draining to it. Generally speaking, the smaller the area draining to a buffer, the more effective it is likely to be.

IMPORTANT

Use the buffer sizing tables in this Chapter to size buffers to meet BMP standards. When used to meet phosphorus allocations in lake watersheds, adjust the sizing of the buffers in accordance with Volume II of this manual.

2. **Location:** Buffers are located downslope of developed areas and along waterways. They should be located directly adjacent to areas for which they are providing treatment. Use of buffers may be limited by location of suitable septic areas, building sites, roads, and driveways. Site planning should provide for the location of buffers as part of the overall development scheme, with consideration of the design criteria listed below. In sensitive lake watersheds requiring phosphorus controls, preliminary planning will need to include determination of the allowable phosphorus export from the site.

5.1.3 General Design and Construction Criteria

1. **Maximum Slope:** The buffer's slope must be less than 15% to be included in the calculation of buffer flow path length. Areas with slopes greater than 15% are too steep to be effective as a treatment buffer but should be left undisturbed. The buffer must have a relatively uniform slope so that stormwater does not concentrate in channels.

2. **Distribution of runoff over the buffer:** To be treated, runoff must enter the buffer as sheet flow and cannot be allowed to channelize.

   Buffers will not treat shallow concentrated or channelized flow. In most cases wooded and non-wooded natural buffers take advantage of the natural micro topography, (the small depressions and mounds of natural ground) to store runoff and allow for maximum infiltration.

3. **Separation from streams:** Buffers must not be interrupted by intermittent or perennial stream channels or other drainage ways.

4. **Restabilization of buffers used for sediment control during construction:** If a buffer has been used to trap sediment during construction, the sediment must be removed and the original topography, ground cover and vegetation reestablished. Otherwise, sediment accumulations may cause runoff to concentrate in certain locations. It is advisable to protect buffer strips with wood waste berm sedimentation barriers during the construction process.

5. **Pretreatment for buffers with "bare soil" contributing areas:** To prevent a heavy sed-iment loading from damaging the buffer, sites that will have areas of bare soil for a long time can not utilize this BMP without first pre-treating the runoff with a sediment control BMP.

6. **Buffer dimensions:** Buffer flow path length depends to some extent on the proposed layout, and may be limited by the location of roads, driveways, building sites, and suitable septic system locations. Overall site design and individual lot configuration can be manipulated to maximize buffer flow-path length while minimizing interference with developed areas. The longer the buffer flow path length, the more effective the buffer is. Only continuous flow path length may be counted. A second buffer separated from the first by a developed area may not be included. The buffer berm length will vary depending on the soil type and vegetative cover of the buffer. Buffer sizing is addressed under each of the four buffer BMPs discussed in this manual.

7. **Topography:** The topography of a buffer area must be such that stormwater runoff will not concentrate as it flows across a buffer, but will remain well distributed. Flow paths of runoff through a buffer must not converge, but must be essentially parallel or diverging. This should be confirmed in the field for each area designated as a buffer.

8. **Vegetative cover:** The vegetative cover type of a buffer must be either forest or meadow. In most instances the sizing of a buffer varies depending on vegetative cover type.

   a. *Forest buffer:* A forest buffer must have a well distributed stand of trees with essentially complete canopy cover, and must be maintained as such. A forested buffer must also have an undisturbed layer of duff covering the mineral soil. Activities that may result in disturbance of the duff layer are prohibited in a buffer.

   b. *Meadow buffer:* A meadow buffer must have a dense cover of grasses, or a combination of grasses and shrubs or trees. A buffer must be maintained as a meadow with a generally tall stand of grass, not as a lawn. It must not be mown more than twice per calendar year. If a buffer is not located on natural soils, but is constructed on fill or reshaped slopes, a buffer surface must either be isolated from stormwater discharge until a dense sod is established, or must be protected by a three inch layer of erosion control mix or other wood waste material approved by the department before stormwater is directed to it. Vegetation must be established using an appropriate seed mix.

   c. *Mixed meadow and forest buffer:* If a buffer is part meadow and part forest, the required sizing of a buffer must be determined as a weighted average, based on the percent of a buffer in meadow and the percent in forest, of the required sizing for meadow and forest buffers.

9. **Deed restrictions and covenants:** Areas designated as buffers must be clearly identified on site plans and protected from disturbance by deed restrictions and covenants. Refer to Appendix D for suggested templates for deed restrictions and conservation easements.

5.1.4 General Maintenance Criteria

1. **Mowing:** Meadow buffers may be mown no more than twice per year. They may not be maintained as a lawn.

2. **Inspection Frequency:** Buffers should be inspected annually for evidence of erosion or concentrated flows through or around the buffer. All eroded areas should be repaired, seeded and mulched. A shallow stone trench should be installed and maintained as a level spreader to distribute flows evenly in any area showing concentrated flows.

3. **Access and Use:** Buffers should not be traversed by all-terrain vehicles or other vehicles. Activities within buffers should be conducted so as not to damage vegetation, disturb any organic duff layer, and expose soil.

4. **Model Maintenance Plan:** The following techniques should be followed to maintain the integrity of buffers from initial planning through post-construction (Schueler, 1994):

a. *<u>Planning Stage</u>*

i. Require buffer limits to be present on all clearing/grading and erosion control plans

ii. Record all buffer boundaries on official maps and site plans.

iii. Clearly establish acceptable and unacceptable uses for the buffer, and include in deed restrictions and conservation easements.

iv. Establish clear vegetation targets and management rules for the buffer.

v. Provide incentives for owners to protect buffers through perpetual conservation easements rather than deed restrictions.

b. *<u>Construction Stage</u>*

i. Pre-construction stakeout of buffers to define the Limit of Disturbance (LOD).

ii. Set LOD based on drip-line of the forested buffer.

iii. Conduct pre-construction meeting to familiarize contractors and foremen with LOD and buffer limit.

iv. Mark the LOD with silt fence barrier, signs or other methods to exclude construction equipment.

c. *<u>Post-Development Stage</u>*

i. Mark buffer boundaries with permanent signs (or fences) describing allowable uses.

ii. Educate property owners/homeowner associations on the purpose, limits and allowable uses of the buffer.

iii. Conduct periodic "buffer walks" to inspect the condition of the buffer network (using volunteers, where possible).

iv. Replant unused meadow buffers with trees and shrubs, if possible.

5.2 Types of Buffers

5.2.1 Buffer Adjacent to Residential, Largely Pervious or Small Impervious Areas

A buffer adjacent to residential, largely pervious or small impervious areas is for small developments where runoff enters the buffer as sheet flow without the aid of a level spreader. Figure 5-1 shows a typical buffer of this type. It may only be used when it is located immediately downhill of the developed area and runoff enters as sheet flow. This design is not appropriate for treating large impervious areas because, even if pavement is graded evenly, it is likely that some concentration of runoff will occur as the stormwater travels across large areas of pavement. Only runoff from the following areas may be treated using this type of buffer:

- A single family residential lot draining to buffer;
- A developed area with less than 10% imperviousness where the flow path over the portion of the developed area for which treatment is being credited does not exceed 150 feet; or
- An impervious area of less than one acre, where the flow path across the impervious area does not exceed 100 feet.

In addition to the general design and construction criteria, provided in the beginning of this Chapter, the following criteria must also be applied in the design and construction of a buffer adjacent to residential, largely pervious or small impervious areas.

IMPORTANT
Design Tips–Buffer Adjacent to Residential, Largely Pervious or Small Impervious Areas

- Buffers adjacent to residential, largely pervious or small impervious areas are for small developments. They are not appropriate for treating large impervious areas.
- Runoff must enter the buffer as sheet flow without the aid of a level spreader.
- The buffer must be located downhill of the developed area.

1. **Slope:** A buffer meeting this standard is not allowed on natural slopes in excess of 15%.

2. **Soil Restrictions:** A buffer meeting this stan-dard is not allowed on Hydrologic Soil Group D soils except that a forested buffer is allowed if the D soils in a buffer are not wetland soils.

3. **Buffer Sizing:** Sizing depends only on the soil type and vegetative cover type of a buffer. Tables 5-1 and 5-2 indicate the required buffer flow path length based on soil types and vegetative cover types. Buffers described by this Chapter must be located downhill of the entire developed area for which it is providing stormwater treatment, such that all runoff from the entire developed area has a flow path through the buffer at least as long as the required length of flowpath.

Table 5-1
Required Buffer Flow Path Length Per Soil and Vegetative Cover Types with 0-8% Buffer Slope

Hydrologic Soil Group of Soil in Buffer	Length of Flow Path for a Forested Buffer (feet)	Length of Flow Path for a Meadow Buffer (feet)
A	45	75
B	60	85
C Loamy Sand or Sandy Loam	75	100
C Silt Loam, Clay Loam or Silty Clay Loam	100	150
D Non-Wetland	150	Not Applicable

Table 5-2
Required Buffer Flow Path Length Per Soil and Vegetative Cover Types with 9-15% Buffer Slope

Hydrologic Soil Group of Soil in Buffer	Length of Flow Path for a Forested Buffer (feet)	Length of Flow Path for a Meadow Buffer (feet)
A	54	90
B	72	102
C Loamy Sand or Sandy Loam	90	120
C Silt Loam, Clay Loam or Silty Clay Loam	120	180
D Non-Wetland	180	Not Applicable

5.2.2 Buffer with Stone Bermed Level Lip Spreader

A buffer with stone bermed level lip spreaders consists of a bermed level spreader followed by a buffer. Runoff is directed behind the stone berm, which is constructed along the contour at the upper margin of a buffer area. The runoff then spreads out behind the berm so that it seeps through the entire length of the berm and is evenly distributed across the top of a buffer as sheet flow. Figure 5-2 shows a typical buffer with stone bermed level lip spreader. This type of buffer must be used when treating stormwater runoff from any of the following:

- An impervious area greater than one acre;
- Impervious areas where the flow path across the impervious area exceeds 150 feet; or
- Developed areas, including lawns and impervious surfaces, where runoff is concentrated, intentionally or unintentionally, so that it does not run off in well-distributed sheet flow when it enters the upper end of a buffer, except that road ditch runoff may be treated using a ditch turn out buffer.

In addition to the general design and construction criteria, provided in the beginning of this Chapter, the following criteria must also be applied in the design and construction of a buffer with stone bermed level lip spreaders.

1. **Stone berm specifications:** The berm must be well-graded and contain some small stone and gravel so that flow through the berm will be restricted enough to cause it to spread out behind the berm. The stone berm must be at least 1.5 feet high and 2.0 feet across the top with 2:1 side slopes constructed along the contour and closed at the ends. Unless otherwise approved by the department, the design must include a shallow, 6-inch deep trapezoidal trough with a minimum bottom width of three feet, and with a level downhill edge excavated along the contour on the uphill edge of the stone berm.

IMPORTANT
Design Tips - Buffer with Stone Bermed Level Lip Spreader

- Stone berm must be well-graded and contain small stone and gravel to force flows to spread out behind the berm.
- Stone berm must be at least 1.5' high and 2.0' across the top with 2:1 side slopes.
- Provide a shallow, 6" deep trapezoidal trough with a minimum bottom width of 3' along uphill edge of berm.
- Buffer with stone berm not allowed on Hydrologic Soil Group D soils identified as wetland soils.
- Required berm length varies by the Hydrologic Soil Group of the soils in a buffer and by the length of flow path.

2. **Stone size:** The stone must be coarse enough that it will not clog with sediment. Stone for stone bermed level lip spreaders must consist of sound durable rock that will not disintegrate by exposure to water or weather. Fieldstone, rough quarried stone, blasted ledge rock or tailings may be used. The rock must be well-graded within the limits provided in Table 5-3, or as otherwise approved by the department.

Table 5-3 Berm Stone Size		
Sieve Designation (Metric)	**Sieve Designation (US Customary)**	**Percent By Weight Passing Square Mesh Sieves**
300 mm	12 in	100
150 mm	6 in	84-100
75 mm	3 in	68-83
25.4 mm	1 in	42-55
4.75 mm	No. 4	8-12

3. **Slope:** A buffer meeting this standard is not allowed on natural slopes in excess of 15% unless a buffer has been evaluated using a site specific hydrologic buffer design model approved by the department, and measures have been included to ensure that runoff remains well-distributed as it passes through a buffer.

4. **Soil Restrictions:** A buffer meeting this stan-dard is not allowed on Hydrologic Soil Group D soils that are identified as wetland soils.

5. **Buffer sizing:** The required size of a buffer area below the stone bermed level lip spreader varies with the size and impervi-ousness of the developed area draining to a buffer, the type of soil in a buffer area, the slope of a buffer, and the vegetative cover type. Tables 5-4 and 5-5 indicate the required berm length per acre of impervious area and lawn draining to a buffer for a given length of flow path through a buffer. Required berm length varies by the Hydrologic Soil Group of the soils in a buffer and by the length of flow path through a buffer. If more than one soil type is found in a buffer, the required sizing of a buffer must be determined as weighted average, based on the percent of a buffer in each soil type, of the required sizing for each soil type buffer. Alternative sizing may be allowed if it is determined by a site-specific hydrologic buffer design model approved by the department.

NOTE: The following tables were developed using a 1.25 inch, 24 hour storm of type III distribution, giving a maximum unit flow rate of less than 0.009 cfs per foot.

Table 5-4
Required Berm and Flow Path Length of a Buffer with 0-8% Slope and a Stone Bermed Level Lip Spreader

Hydrologic Soil Group	Length of Flow Path through Buffer (feet)	Berm Length for a Forested Buffer (feet)		Berm Length for a Meadow Buffer (feet)	
		Per acre of impervious area	Per acre of lawn	Per acres of impervious area	Per acre of lawn
Soil Group A	75	75	25	125	35
	100	65	20	75	25
	150	50	15	60	20
Soil Group B	75	100	30	150	45
	100	80	25	100	30
	150	65	20	75	25
Soil Group C sandy loam or loamy sand	75	125	35	150	45
	100	100	30	125	35
	150	75	25	100	30
Soil Group C silt loam, clay loam or silty clay loam	100	150	45	200	60
	150	100	30	150	45
Soil Group D non-wetland	150	150	45	200	60

Table 5-5
Required Berm and Flow Path Length of a Buffer with 9-15% Slope and a Stone Bermed Level Lip Spreader

Hydrologic Soil Group	Length of Flow Path through Buffer (feet)	Berm Length for a Forested Buffer (feet)		Berm Length for a Meadow Buffer (feet)	
		Per acre of impervious area	Per acre of lawn	Per acre of impervious area	Per acre of lawn
Soil Group A	75	90	30	150	42
	100	78	24	90	30
	150	60	18	72	24
Soil Group B	75	120	36	180	54
	100	96	30	120	36
	150	78	24	90	30
Soil Group C sandy loam or loamy sand	75	150	42	180	54
	100	120	36	150	42
	150	90	30	120	36
Soil Group C silt loam, clay loam or silty clay loam	100	180	54	240	72
	150	120	36	180	54
Soil Group D non-wetland	150	180	54	240	72

5.2.3 Buffer Adjacent to the Down Hill Side of a Road

A buffer adjacent to the down hill side of a road consists of a buffer directly adjacent to a roadway. The road must be parallel to the contour of the slope. It may only be used when the runoff from the road surface and shoulder sheets immediately into the buffer. In no instance may runoff from areas other than the adjacent road surface and shoulder be directed to these buffers. Figure 5-3 shows a typical buffer adjacent to the down hill side of a road.

In addition to the general design and construction criteria, provided in the beginning of this Chapter, the following criteria must also be applied in the design and construction of buffers adjacent to the down hill side of a road.

1. **Slope:** A buffer meeting this standard is not allowed on natural slopes in excess of 20%.

2. **Soil Restrictions:** A buffer meeting this stan-dard is not allowed on soils identified as wet-land soils.

3. **Buffer Sizing:** Sizing depends only on the vegetative cover type of a buffer and the num-ber of travel lanes draining to a buffer. Table 5-6 indicates the required buffer flow path length based on the number of travel lanes draining to the buffer and whether the buffer is forested or meadow.

4. **Inclusion of inslope:** The inslope of the roadbed may be included as part of a meadow buffer only if it is designed and constructed to allow infiltration. Design and construction to allow infiltration includes, but is not limited to, the inslope fill material being a sandy loam or coarser soil texture having slopes no steeper than 4:1; loaming and seeding to meadow grasses; and maintaining a buffer area as a meadow buffer.

IMPORTANT
Design Tips - Buffer Adjacent to the Down Hill Side of a Road

The in slope of the roadbed may only be included as part of a meadow buffer if it is designed and constructed to allow infiltration.

Table 5-6
Required Buffer Flow Path Adjacent to the Down Hill Side of a Road

	Length of Flow Path for a Forested Buffer (feet)	Length of Flow Path for a Meadow Buffer (feet)
One travel lane draining to buffer	35	50
Two travel lanes draining to buffer	55	80

5.2.4 Ditch Turn Out Buffer

A ditch turn-out buffer is used to divert runoff collected in a roadside ditch into a buffer. It consists of a combination of checkdams and bermed level lip spreaders used to divert concentrated ditch flows into a buffer as sheet flow. Runoff backs up behind the checkdam and is directed over a stone berm that spreads flows out so that it is evenly distributed across the top of a buffer as sheet flow. Figure 5-4 shows a typical ditch turn-out buffer.

IMPORTANT
Design Tips - Ditch Turn-Out Buffer

- A ditch turn-out buffer uses a combination of checkdams and bermed level lip spreaders to divert concentrated ditch flows into a buffer as sheet flow.
- Refer to buffer sizing tables in this section.

In addition to the general design and construction criteria, provided in the beginning of this Chapter, the following criteria must also be applied in the design and construction of a ditch turn-out buffer.

1. **Drainage Area:** No areas other than the road surface, road shoulder and road ditch may be directed into the buffer. No more than 400 ft of road and ditch may be treated in any ditch turn-out buffer, and no more than 250 feet may be treated if more than one travel lane is draining to the ditch.

2. **Distribution of runoff over the buffer:** The turnout should extend into the side ditch or cut slope in a manner that it intercepts the ditch runoff and carries it into the buffer area. The buffer end of the turnout must be level and equipped with a stone bermed level spreader.

3. **Stone berm specifications:** The stone berm to which the ditch turn-out delivers the runoff must be at least 20 feet in length and must be constructed along the contour. It must be at least one- foot high and two feet across the top with 2:1 side slopes.

4. **Stone size:** Stone for the berm must consist of sound durable rock that will not disintegrate by exposure to water or weather. Fieldstone, rough quarried stone, blasted ledge rock or tailings may be used. The rock must be well graded with a median size of approximately 3 inches and a maximum size of 6 inches.

5. **Slope:** A buffer meeting this standard is not allowed on natural slopes in excess of 15%.

6. **Soil Restrictions:** A buffer meeting this stan-dard is not allowed on Hydrologic Soil Group D soils with wetlands.

7. **Buffer sizing:** The required size of a buffer area below the turnout's stone bermed level lip spreader varies with the type of soil in a buffer area, the slope of a buffer, the length of road ditch draining to a buffer and the vegetative cover type within a buffer. Tables 5-7 and 5-8 indicate the required length of the flow path through a buffer for various vegetative covers and ditch lengths. If two travel lanes drain to the ditch, as in the case of a super elevated road, the length of flow path indicated for 400 feet of road must be used, but no more than 250 feet of ditch may drain to each turn-out.

Table 5-7
Required Buffer Flow Path Length Per Length of Road or Ditch with 0-8% Buffer Slope

Hydrologic Soil Group of Soil in Buffer	Length of Road or Ditch Draining to a Buffer (feet)	Length of Flow Path for a Forested Buffer (feet)	Length of Flow Path for a Meadow Buffer (feet)
A	200	50	70
	300	50	85
	400	60	100
B	200	50	70
	300	50	85
	400	60	100
C Loamy Sand or Sandy Loam	200	60	100
	300	75	120
	400	100	Not applicable
C Silt Loam, Clay Loam or Silty Clay Loam	200	75	120
	300	100	Not applicable
D Non-wetland	200	100	150

Table 5-8
Required Buffer Flow Path Length Per Length of Road or Ditch with 9-15% Buffer Slope

Hydrologic Soil Group of Soil in Buffer	Length of Road or Ditch Draining to a Buffer (feet)	Length of Flow Path for a Forested Buffer (feet)	Length of Flow Path for a Meadow Buffer (feet)
A	200	60	84
	300	60	102
	400	72	120
B	200	60	84
	300	60	102
	400	72	120
C Loamy Sand or Sandy Loam	200	72	120
	300	90	144
	400	120	Not applicable
C Silt Loam, Clay Loam or Silty Clay Loam	200	90	144
	300	120	Not applicable
D Non-wetland	200	120	180

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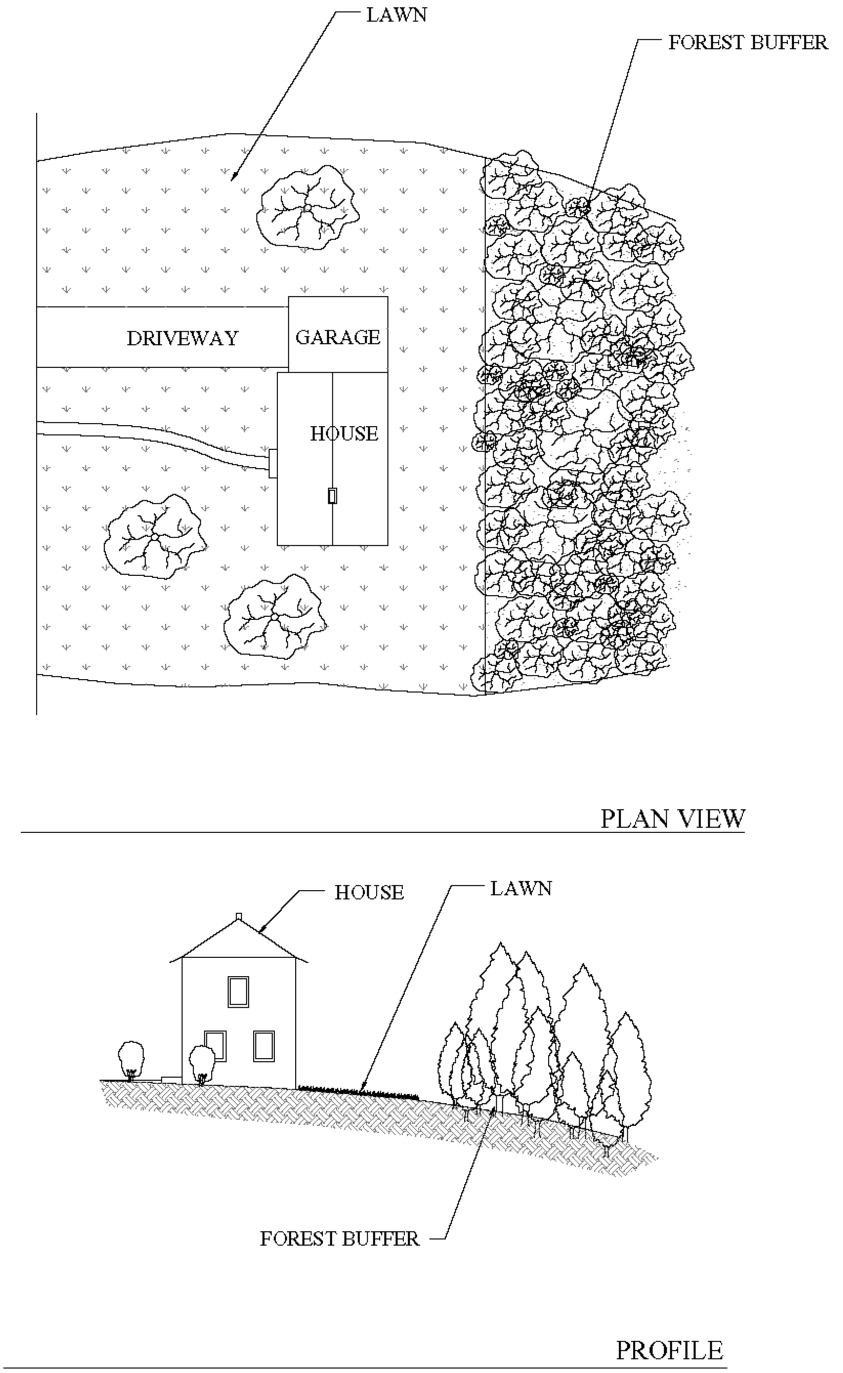

FIGURE 5-1. BUFFER ADJACENT TO RESIDENTIAL AREAS

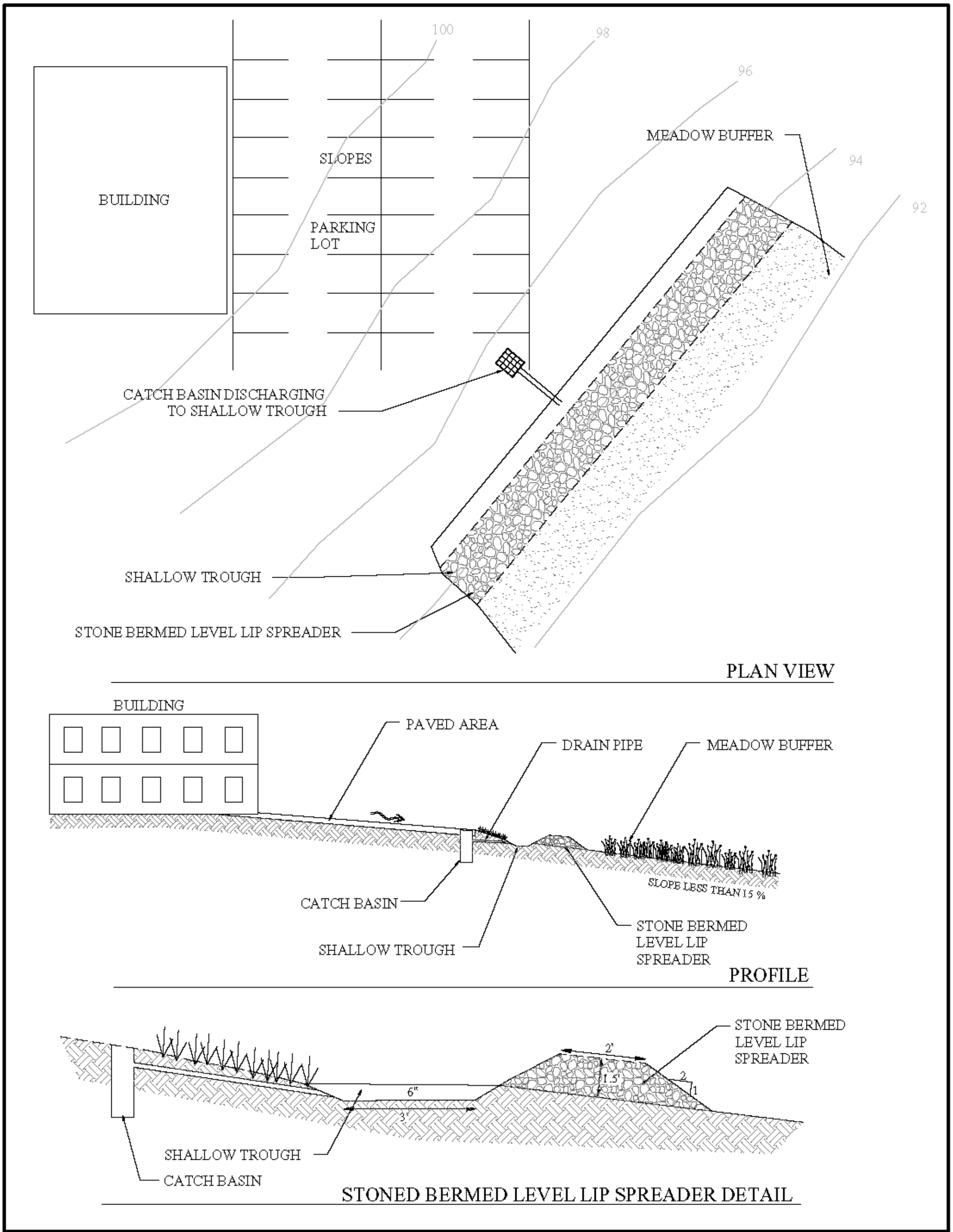

FIGURE 5-2. BUFFER WITH STONE BERMED LEVEL LIP SPREADER

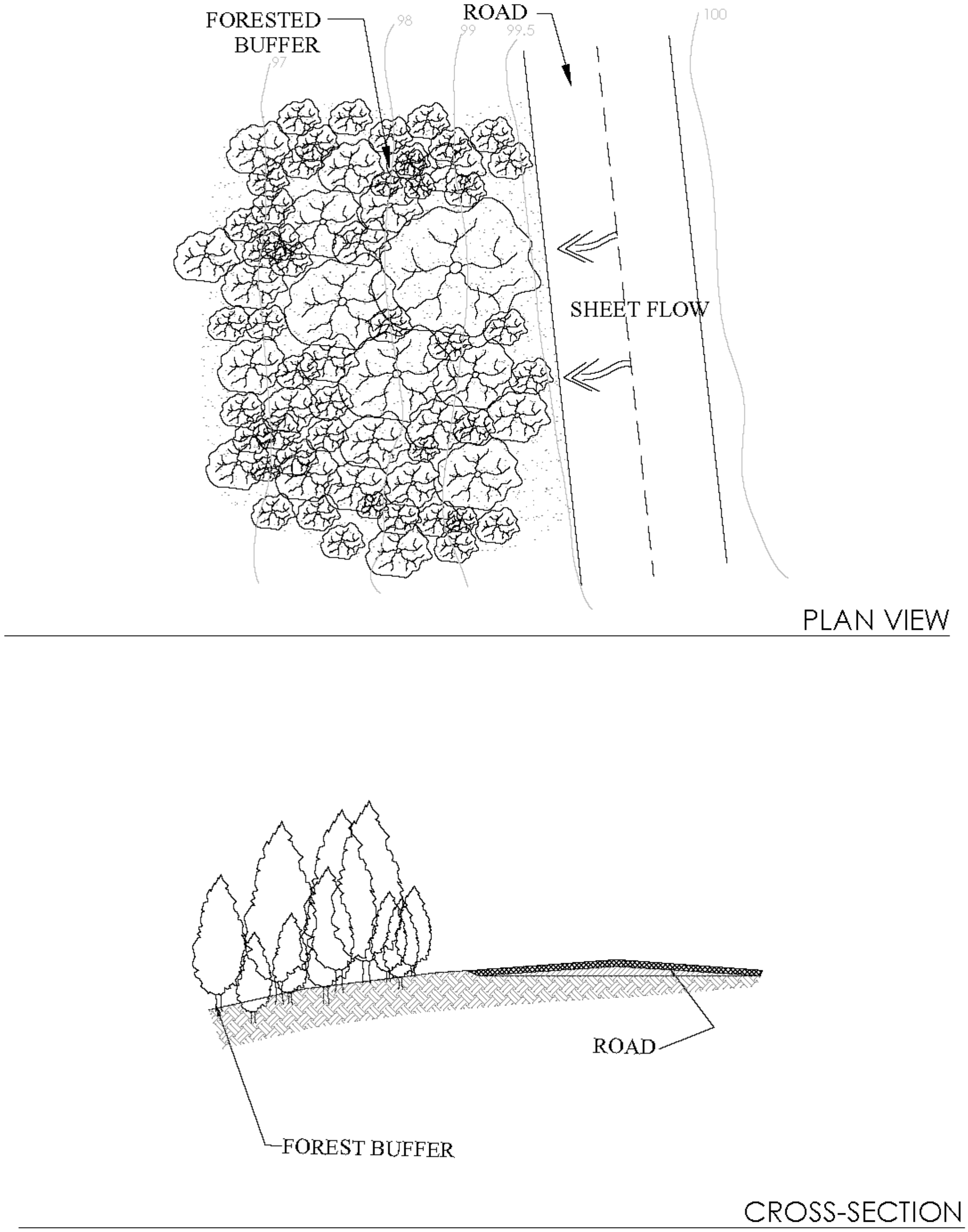

FIGURE 5-3. BUFFER ADJACENT TO THE DOWNHILL SIDE OF A ROAD

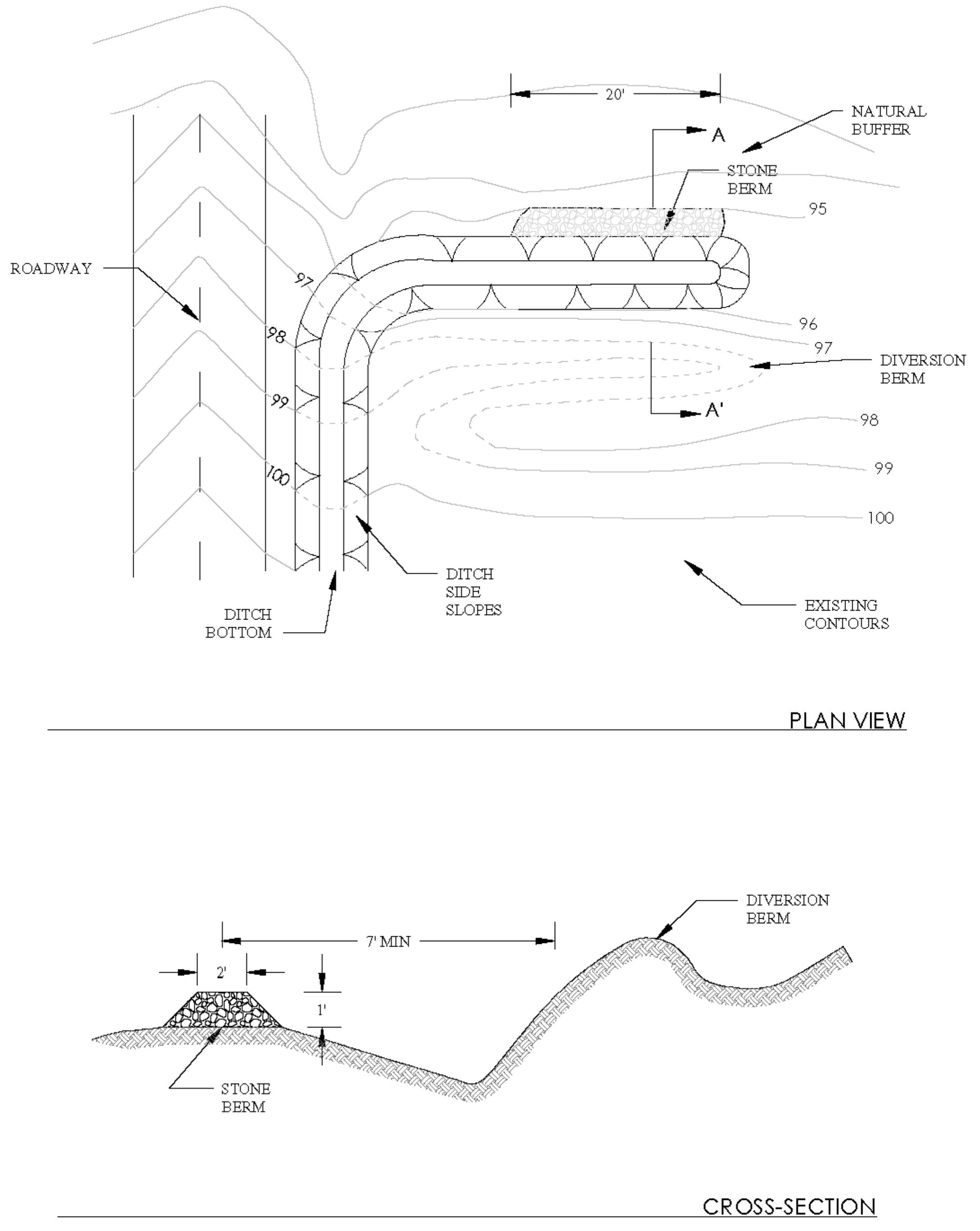

FIGURE 5-4. TYPICAL DITCH TURNOUT BUFFER